WOODS AND TREES[1]

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Some of you, I am sure, are wondering why a zoologist should presume to discuss a subject which apparently lies within the domain of the botanist. Of course to be strictly zoological I might have used the words formicaries and ants, but no one before me has said, "One can't see the formicary for the ants," and I do not presume to establish a saying.

I have had considerable experience instructing the general arts college student, the student who takes zoology as a college requirement and without thought of continuing in the field beyond the limits of the course. Each year at about this season, after all the tumult and the shouting of instruction have died down, in the wee small hours of the fading academic year, I take stock and ask myself in troubled seriousness, "What have I conveyed to my charges?" Facts, most certainly; but facts without their significance are as food without vitamins. One is filled but does not thrive. Hence, I query, have I been content to show to my students merely the trees of fact, each after each in all their intricacy of detail, or have I also taken them to a vantage point and shown them the beauty and majesty of the forest? Have I, in other words, taken full advantage of the opportunities which President Brown of Denison at our last meeting so eloquently ascribed to the instructors of science. You will remember that in the course of his remarks he humorously itemized the tongue twisting terms that met his gaze as he reviewed the requisitions of his scientific staff. President Brown, however, saw beyond the terms and the facts they represent. He saw them as a means not as ends. Unfortunately some members of our scientific fraternity, not to mention the man in the street, see only the terms. Nothing is so revealing, so pathetically revealing, as the desperate efforts the casual acquaintance makes to find a common ground of conversation once he discovers you are a zoologist. All too often he amusingly, likewise tragically, attempts to recall a name—oh, yes, he says, I studied zoology once. Let me see, what is the name for oysters and clams? . . . That man has seen the trees. I wonder whether he was ever shown the woods; whether he was trained in anything but bare facts. And I wonder too whether, perhaps still more unfortunately, the significance of significances was ever appreciated by his instructors.

The trees and not the woods loomed large in the remarks made by a colleague of mine, a purveyor of the humanities, on the occasion of a round table discussion between a faculty group and students on the ever-recurring topic of science and religion. The immediate question at issue was the relation of scientific facts to religion. My colleague was of the opinion that the two could be in no wise related. By way of illustration he pointed to the facts of meteorology; certain conditions of temperature, moisture, atmospheric movement we know result in rain. How can that knowledge possibly have any connection with religion, he queried. The answer, as we well know, is simple. This certainty of results which the meteorological facts represent takes much of the mystery and consequent uncertainty out of the comings and goings of the weather. To just that extent we feel secure and in harmony with the powers that ride the storm.

My colleague's query did double duty. It revealed the barren trees of both science and religion but the woods of neither. The fundamental yearning which

[1]Address of the retiring president of the Ohio Academy of Science delivered at the annual meeting of the Academy held in Columbus, Ohio, April 30, 1943.

the appeal to religion strives to fulfill is the yearning for security, a yearning which grips all of us. We tremble before the overpowering uncertainties of enveloping fate, the unknowable, and strive to achieve a harmonious relationship through religious experience. The woods, which apparently neither the scientific nor the religious experiences of my colleague had revealed to him, were that just as the all compelling quest manifested through religion is the quest for security so the all embracing fruit of science is to afford security; the security that frees from the bonds of uncertainty and superstition and soothes the troubled soul with the peace that passeth understanding.

This doctrine of security, the teaching that we live in an environment ordered by dependable, understandable principles is as old as science itself, the *leit motif* that has threaded its guiding way through scientific thought throughout the ages from the times of the early Ionian teachers to the present. As F. H. Pike[2] reminds us in a published note within the year, "One great change which occurred in the period from Thales to Plato was the substitution of a world, perhaps even a universe, of law for the older world of caprice." And with it there was born a new thing, "science," which as Burnet[3] so aptly defines in his survey of Greek philosophy is "thinking about the world in the Greek way."

To return to my colleague and, I fear, to many others like him, what a woeful void there must have been in what he reaped from science, perhaps also in the guidance offered him by his mentors. One is moved to paraphrase the biblical interrogation, what doth it profit a man to gather the facts of science and lose its soul?

One group of scientific facts, its bare, gaunt trees stripped of their pleasing foliage, tells us that every particle of matter is attracted by every other particle in proportion to the product of the masses and inversely as the square of the intervening distances. These few words represent a vast number of subsidiary facts and a prodigious amount of painstaking effort in their formulation. It is known to all who mull them over that they explain the floating of a mote of dust to the ground and in the same breath the grand movement of the planets through space. I am wondering, however, how many of those who have burnt the midnight oil in mastering these facts, how many of our students, indeed perhaps, how many of their instructors and how many of our friends in the humanities like my colleague of the religious discussion have been taken to a mountain top from which they have been able to see that these same facts have served also as a guide post in our quest of the ultimate, in moulding man's interpretation of his universe, in orienting himself in time and space; that they have been one of the things which has helped to satisfy man's wonder, the awsome wonder that comes over one as he gazes into the depths of a star-studded winter sky where wonder leads to wonder and one is moved to breathe the thought, "What is man that thou art mindful of him?"

As Sir James Jeans[4] points out, "The law of gravity was important not so much because it told us why an apple fell to the ground or why the earth and planets moved around the sun as because it suggested the whole of Nature was governed by hard and fast laws—in the light of Newton's work—Man began to see that he was free to work out his own destiny without fear of disturbance from interfering gods, spirits, or demons." Or again to partly paraphrase Dampier,[5] Newton's reduction of the phenomenon of gravity to mathematical terms, coupled with the work of Copernicus and Galileo, in one grand sweep validated terrestrial mechanics in celestial spaces and eliminated with finality the Aristotelian and

[2]Science, April 24, 1942.
[3]Early Greek Philosophy, 4th Edition, 1930.
[4]"Scientific Progress."
[5]Sir William Dampier, "A History of Science," 1938.

mediaeval doctrine that "the heavenly bodies are divine, incorruptible and different in kind from our imperfect world." The effect was even deeper and struck at the very roots of religious beliefs in that it was made "impossible any longer to gaze into heaven just above the sky, and to shudder at the rumblings of hell beneath the ground." Consequently, as Brett[6] comments, "The seat of religious belief was thus moved from the heart to the head; mysticism was excommunicated by mathematics, . . . the way was opened for a liberal Christianity which might ultimately supersede traditional beliefs."

Incidentally a statement like that is indeed comforting to a zoologist. It lifts from his shoulders some of the burden placed there by the populace for having undermined ancestral beliefs.

Biology's central contribution to human thought has been the doctrine of organic evolution. This doctrine has brought coherence and order and significance to a multitude of otherwise apparently disconnected facts and theories within the field of biology itself and has opened up wide vistas of vision in other fields as well. It is undoubtedly superfluous to mention this to a scientific assemblage such as this, but there are scientists, even biologists, who tend to belittle the importance of evolution in the scheme of instruction. And here again I am moved to wonder whether we see the woods as we look at the trees; whether we consider the fact of the evolutionary origin of animals and plants as an end in itself and the meticulous details of evidence as ends in themselves or whether we look upon them as means to a broader end. As ends in themselves they are probably pleasant bedtime stories, if you like that kind of story. They are facts and add to one's store of such things, if your hobby is making a collection. If that is the spirit in which one presents the matter embellished for good measure with much precise detail, I fear that in the words of the philosopher, Irwin Edman, once applied to some of the humanities, it will be shortly "dying of anemia, of archeological hardening of the arteries and will become a corpse handled conscientiously by solemn morticians."

As means to an end the formulation of the doctrine of organic evolution, like the formulation of the principles of gravity, has served as the factual basis for a reorientation of human conceptions. If Newton paved the way for a liberalized Christianity, Darwin has paved the way for a liberalized socio-political outlook. The doctrine of organic evolution has once and for all destroyed the concept of the immutability of human institutions as well as of animal bodies. It has destroyed finality. If man as an animal is the product of change, his institution, the state, as a socio-political organization is not immutable. What served the purposes of our fathers may not of necessity serve ours. And so also have we been conditioned to discard the concept of absolutism in the field of economics. With changing times come changing economic principles.

Organic evolution with its handmaiden, natural selection, has destroyed the sociological equalitarianism of the French revolution. All men may be equal before the law; they are not equal before the bar of life. Gone too is the categorical dictum as a basis for morality and in its place has come racial experience, those standards which have survival value for the race. Morality in this light comes to mean allegiance to that code which will enable one's countrymen to live and to have life more abundantly. For those who may mourn the passing of the categorical standard, let me say that racial survival is a far more exacting standard than one which, perchance, permits of compensation by doing penance. The youthful monkey merrily swinging from limb to limb who misjudges his mark gets no second chance and leaves no descendants. It is, indeed, easier for a camel to pass through the Needle's Eye than to cheat the laws of life.

[6]G. S. Brett, "Sir Isaac Newton," 1929.

There is tonight no time, even if this could be considered an appropriate place, in which to trace all the ramifications of our racial experience as a standard by which we may order our lives. However, I should like to enlarge upon one phase of our experience which does appear to be peculiarly applicable to the present state of world affairs. Julian Huxley,[7] in discussing man's achievements points out, as have others, that "the next step of greater control must be over man himself . . . through (among other methods) doing away with nationalistic drives and superimposing an international form of government on the world." To a biologist there straightway comes the question, what evidence have we that cooperation is any more successful than isolation as a biological method? Has not the arch isolationist, Amoeba, survived for millions of years and have not thousands of other rugged individualists been successful among the animal hordes? That interrogation immediately poses another—what is success? And to answer one must differentiate between survival and mastery. An animal, all of us, may survive through a variety of devious subterfuges and expedients, the common mark of which is that they entail subservience. However, success in fullest measure is mastery over conditions. If organic evolution has any significance it is the story of how living material has through the cooperative actions of its subdivided units approached, if it has not yet attained, mastery.

I am fully aware of the fact that organic evolution does not of necessity proceed along a straight line principle, that life has followed a thousand and one devious pathways and on occasion has even retrogressed; but the fact remains, nevertheless, that at each level on which there has been a closer approach to mastery that approach has been accompanied by a greater division of labor and a closer coordination of the constituent units until in man the master, they have become woven into an intricate pattern of cooperating parts. At the opposite extreme lies an ineffectual, single-celled droplet of living material exemplified by Amoeba. Organic evolution is thus history, as much a part of our history as is the history of the written word, and as such, in fulfilling one of its functions, it points out the road we have trod and lights the way that lies ahead.

I am a zoologist, but for a moment I should like to turn historian, that man who has been termed by Schlegel a prophet looking backward, and as such a prophet refresh your memories by briefly tracing the steps of this story as others have done before me.

It can begin with Amoeba, a creature which epitomizes individualism. Not even in the commonly shared function of reproduction is it dependent upon another for assistance. A thousand and one changes have been rung on this isolationist-individualist theme among its fellow protozoans, each change having brought survival but no shred of mastery.

One of the early mutations leading out of the protozoan doldrums was that which resulted in causing proliferating cells to remain clustered together, and as such clusters to cooperate in the form of tubular units; a condition exemplified in varying degrees by the Porifera and the Coelenterata. The rewards were those that come from numbers and elementary divisions of function. This condition was followed by an innovation which resulted in dense, compact and solid masses of cells being able to exist as a single unit exemplified by our friends and tormentors, the flatworms. This state of affairs was accompanied by greater diversification in the constituent units and preeminently by rectilinear locomotion.

The next steps—three of them—in this mutating series were particularly significant; the development of distance receptors, the device which produced essentially compound animals, and the accompanying delegation of authority to subcenters which thus made possible the rapid and efficient control so characteristic of the metameric groups.

[7] "Man Stands Alone," 1940.

Metamerism is as far as life has gone in the way of physically compounding units. The compounding has continued but on the psychological level, or social level if you wish. If we are to consider psychological reactions as a specialized manifestation of physiological states, the continued compounding which we term our social organization is fully as much a physiological process as were the physical unions just outlined and as such must be considered a direct continuation of this compounding tendency, a continuation made possible by the development of distance receptors.

In saying this, I am mindful of those who maintain that social organization is not comparable to corporate organization. I am inclined to think the difference is not so much a matter of principle as of means. In the one case the constituent units have been held together by bonds of physical contact, in the other they have been as firmly held by the influence of distance receptors. Emerson,[8] the ecologist, has recently expressed the view that, "Regardless of how one interprets the unity of the more complex human societies, the human family, and other family systems, are real cooperative, supra-organismic entities. . . . Society is merely a manifestation of fundamental life attributes which are shared with other biological systems (e.g., multicellular organisms) and the division between the social and the non-social is not sharp." Jennings[9] goes further and points out that there is much to be said in favor of the conclusion that "mankind is a single great organism temporarily divided into pieces—the individuals." Through this device the essential benefits of physical union are retained and become enriched by the advantages to be derived from mobile units. The study of organic evolution is, indeed, from one standpoint essentially a study in populations. Much can be said in support of the conclusion emerging from such a study, that in its animal phases at least unitary masses of protoplasm, whether these units be cells or bodies, under similar conditions follow essentially similar principles of group organization.

The social organization of the corporate population has, as you know, followed along two lines, the one illustrated by certain insects, the other by man. Among insects the culmination is reached by the ants and the termites, those individually defenseless creatures and toothsome morsels for many a foe which have through cooperation lived from the tropics to the borders of the Arctic.

Our own social structure is an even more intricate and widespread culmination of increasingly interdependent component units the progress of which has followed one unswerving path marked by the milestones of free cells, tissues, organs, organ systems, compound organisms, then families, tribes, kingdoms, empires, major alliances, and still it holds its course into the future. Faintly outlined as yet but apparently on our course lies some type of world union. This last prophecy may be branded an ultra-utopian fancy, but it must not be thought that the pyramiding of units I have just traced whether in the field of physical union or socio-political associations came without a struggle, without false starts that led up blind alleys or, indeed, ended in stark failure.

For those who may be faint-hearted, the fact to be kept in mind is that with all the difficulties that beset the way, union was eventually accomplished, that with each union, with each sacrifice of self, with each restriction of liberty, there has been a stride toward greater mastery, toward a fuller, more abundant life for the whole. At one extreme is individualism, represented by Amoeba, beholden by neither jot nor tittle to anyone, grovelling withal in the slime and swept hither and yon by every whim of nature. At the other extreme are millions of interdependent cells united in the form of men who, in turn, through their combined efforts have overcome the sufferings of famine, the scourge of pestilence, the barriers of distance, the mysteries of the air, yes, even the intricacies of creative

[8]A. E. Emerson, Denison University Bulletin, December, 1941.
[9]Journal of Social Philosophy, January, 1937.

synthesis. Optimism for the future is well expressed in the words of the palaeontologist, Lull,[10] who writes, "The great heart of nature beats, its throbbing stimulates the pulse of life, and not until that heart is stilled forever will the rhythmic tide of progress cease to flow."

Among the social insects the price paid to the group for the benefits of cooperative action is that the individual be born to a class and have stamped upon him unalterably the form of his station in life—worker, soldier, king or queen—there to remain toiling dutifully without will or choice that the group may survive. That is straight-jacketed, inflexible efficiency, not inviting to those of us outside the pale of Nazi or Fascist rule. It has, moreover, fallen short of control, probably because its morphological inflexibility is paralleled by inflexibility of nervous reaction.

There is no gainsaying that one of the most patent of biological principles requires that when individual and species conflict, it is the individual that must give way even to the extreme of life itself. For us the demands of society are indeed becoming more and more exacting; we are individually being held to a closer and closer accounting. There is ever-increasing regimentation. But we of the vertebrate line are fortunate in that we belong to a type of social organization which permits its members the opportunity of realizing their responsibility to the group and of doing their duty voluntarily and without compulsion. If we but will, therein lies our avenue of escape from the fate of an enforced regimentation analogous to that of the insects.

The responsibility which rests upon us individually arises from the division of labor inherent in society. Each sequence in the evolutionary progress of living material from microscopic unit to dominating mass involved more and more detailed division of labor and with each advance there came increasing responsibility. For instance, in an unspecialized body like that of a sponge the entire body, as you well know, can be taken apart cell by cell and then the whole mass or any portion of it can again take on the form and function of a sponge. Here, it matters little whether any one or a group of cells fail. At the opposite extreme in man, the loss of an islet of cells in the pancreas means death. Clearly specialization and responsibility go hand in hand.

The inexorable demands of nature that each do his duty to his kind need not of necessity mean that before us lies a future in which we shall be slaves to the State, Nazi-fashion. A slave performs his duty without choice, has no voice in his fate. Before us lies the opportunity to both exercise our choice and discharge our duty. If, however, we do not so choose, we shall have responsibility and no freedom, no chance to direct our fate. There are even now those among us who would impose the prototype of insect rigidity upon our form of social organization. Its most extreme exponents are the followers of Nazi philosophy. Rauschning[11] reports Hitler as declaring, "There will be a master class . . . also a new middle class . . . and the great mass of the eternally disfranchized. Beneath them still will be . . . the modern slave class. . . . Universal education is the most corroding and disintegrating poison that liberalism has ever invented for its own destruction." Carrel[12] has expressed somewhat similar views as for instance, . . . "The democratic principle has contributed to the collapse of civilization in opposing the development of an elite. . . . modern civilization is incapable of producing people endowed with imagination, intelligence and courage. . . . the equality of their (man's) rights is unequal."

It is true that there are biological differences among us which cause difficulties in a democratic state, but gene distribution is such that few are wholly of inferior

[10]R. S. Lull, "Organic Evolution," 1929.
[11]"The Voice of Destruction."
[12]"Man, the Unknown."

quality and few, if any, of wholly superior stuff. The mechanism of transmission and interaction of genes further complicates the picture. And who is to differentiate what is good or how? As Jennings suggests, "One of the greatest difficulties in the way of effective human action lies in the lack of agreement as to the end to be attained. . . . perhaps the greatest difficulty of all lies in the lack of agreement as to the individuals or groups that should benefit by the action to be taken."

The course upon which the physically undifferentiated and mobile fabric of the vertebrate social organization is set does not of necessity demand a society straight-laced and closely regimented in which freedom of action is surrendered. It does demand and will exact the surrender of action for self alone. It does place upon us unalterably responsibility to our fellow men. The failure on the part of many of us, most of us I fear, to realize this fact has been an important source of our present unrest. With a sense of allegiance to the group in the spirit of that larger self-interest which realizes that the greatest good for the individual is inextricably bound up with the good of the group, there need be no fear of enforced regimentation. Unlike the straight-jacketed insect civilization, such realization of individual responsibility permits us freedom to pass from stratum to stratum as the cast of the genes may decide and leaves us the stimulus of individual initiative. The specializations of society without a sense of responsibility lead to the limited privilege of an unbridled, cancerous growth; specialization with a sense of the common good leads to the harmony of a well-ordered body.

As I come to the end of my remarks let me mention once again my thoughts at the close of the academic year, my interest in the trees of fact and the woods of significance. I have, as you see, directed your attention to but a few examples. First among them was the very soul of science, the sense of security which scientific facts convey. Second was the influence of what may appear to be purely physical principles upon the liberation of man from the bonds of religious ignorance; third, the significance of the facts of evolution as a guiding light upon our way and finally the significance of the individual's obligation to the group. I have discussed them because with all the immediately practical applications of fact that can be made, which are truly many and important, such applications alone are not sufficient. The instructor in science has not completely fulfilled his responsibility to those who come to him for guidance unless he has pointed out the wider significances. These broader applications which carry us into the realm of ideas are required to fully satisfy that age-long quest which Sir William Dampier has so richly clothed in these words:

"At first men try with magic charm
To fertilize the earth,
To keep their flocks and herds from harm
And bring new young to birth.

Then to capricious gods they turn
To save from fire or flood;
Their smoking sacrifices burn
On altars red with blood.

Next bold philosopher and sage
A settled plan decree,
And prove by thought or sacred page
What Nature ought to be.

But Nature smiles—a Sphinx-like smile—
Watching their little day
She waits in patience for a while—
Their plans dissolve away.

Then come those humbler men of heart
With no completed scheme,
Content to play a modest part,
To test, observe, and dream.

Till out of chaos come in sight
Clear fragments of a Whole;
Man, learning Nature's ways aright,
Obeying, can control."